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As part of a previous USAF/AFOSR funded Phase II SRIR/STTR research project, P49620-99-0-006-i, HPS Simulations developed a combat simulation software package capable of modeling the effects of conventional and advanced weapons on the modern battlefield including those based on High Powered Microwaves (HPM), Lasers, and other forms of radiation. This simulation is titled: Point Of Attack-2 (POA-2).

The United States has always been at risk from small-scale independent attacks against vital military and civilian installations. Unfortunately, recent world events would seem to have made the probability of such an attack more likely than ever. Given that the results of even a moderately successful attack could have far-reaching and exceedingly damaging consequences, prevention and repulsion of such attacks are of utmost importance. At the same time, finding weapons and methods that leave a significant number of attackers available for questioning after the attack would also be of the greatest advantage.

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Final Report

HPS Simulations

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1. Introduction

As part of a previous USAF/AFOSR funded Phase II SRIR/STTR research project, F49620-99-C-006-1, HPS Simulations developed a combat simulation software package capable of modeling the effects of conventional and advanced weapons on the modern battlefield, including those based on High Powered Microwaves (HPM), Lasers, and other forms of radiation. This simulation is titled: ***Point Of Attack-2 (POA-2)***.

The United States has always been at risk from small-scale independent attacks against vital military and civilian installations. Unfortunately, recent world events would seem to have made the probability of such an attack more likely than ever. Given that the results of even a moderately successful attack could have far-reaching and exceedingly damaging consequences, prevention and repulsion of such attacks are of utmost importance. At the same time, finding weapons and methods that leave a significant number of attackers available for questioning after the attack would also be of the greatest advantage.

2. Project Objectives

The objective of the project was to research how the existing POA-2 software can be used to model small level attacks on critical installations, and how advanced energy weapons and other non-conventional systems can be used in these situations to best advantage.

In particular, the area of Kirtland AFB, New Mexico, was entered into the modeling system, and plausible scenarios of attacks on this base were developed.

3. Work Carried Out

The research was broken down into 3 primary areas:

a) Research and modification of the original software as necessary to make it effective for terrorist-type attacks.
b) Enter the Kirtland AFB area into maps useable by the software.
c) Develop weapons systems and scenarios that reasonably represent those used by terrorists, and run those scenarios with the software to gain insight into the form and final results of these types of attacks.

To achieve these objectives, the work effort was broken down into 5 discrete steps:

1) Develop maps of the Kirtland AFB area compatible with the existing analysis software.
2) Enter an assortment of conventional and non-conventional weapons into the software database, including HPM and other energy weapons, from unclassified information.
3) Develop several scenarios of terrorist attacks on the base.
4) Allow for government users to edit the weapons values, using classified or other data.
5) Adjust the damage calculations as necessary to achieve accurate results for all weapons systems.

3.1. Develop maps of the Kirtland AFB area compatible with the existing analysis software.

Approximately 250 square kilometers of the Kirtland main base area, as well as the surrounding urban areas, airport and runways were entered into a format compatible with the analysis software. The maps were entered directly from available topographic maps of the area, and these maps are included and available for view/use by the user. Additionally, aerial photographs of the area were used at the "highest" zoom level.

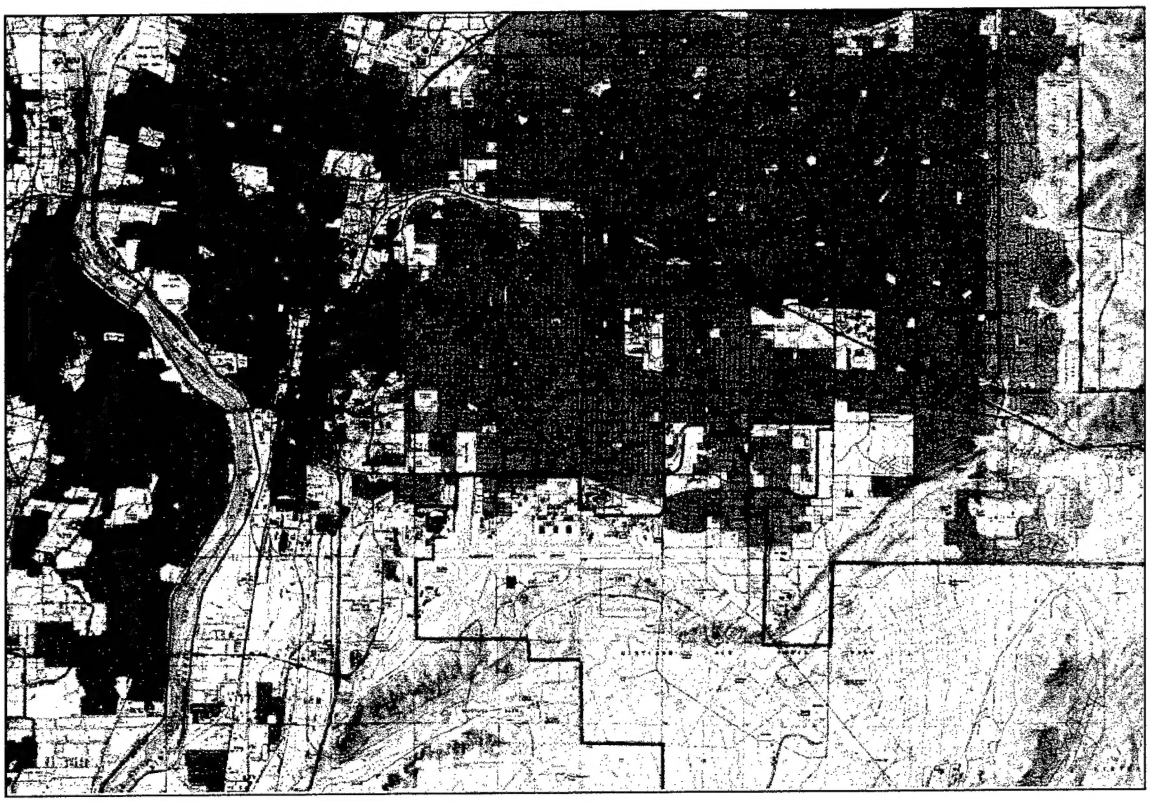


Figure 1: "Full map" coverage area of Kirtland AFB and Albuquerque, New Mexico. This topographic map is used at zoom levels 1 and 2 in the simulation.

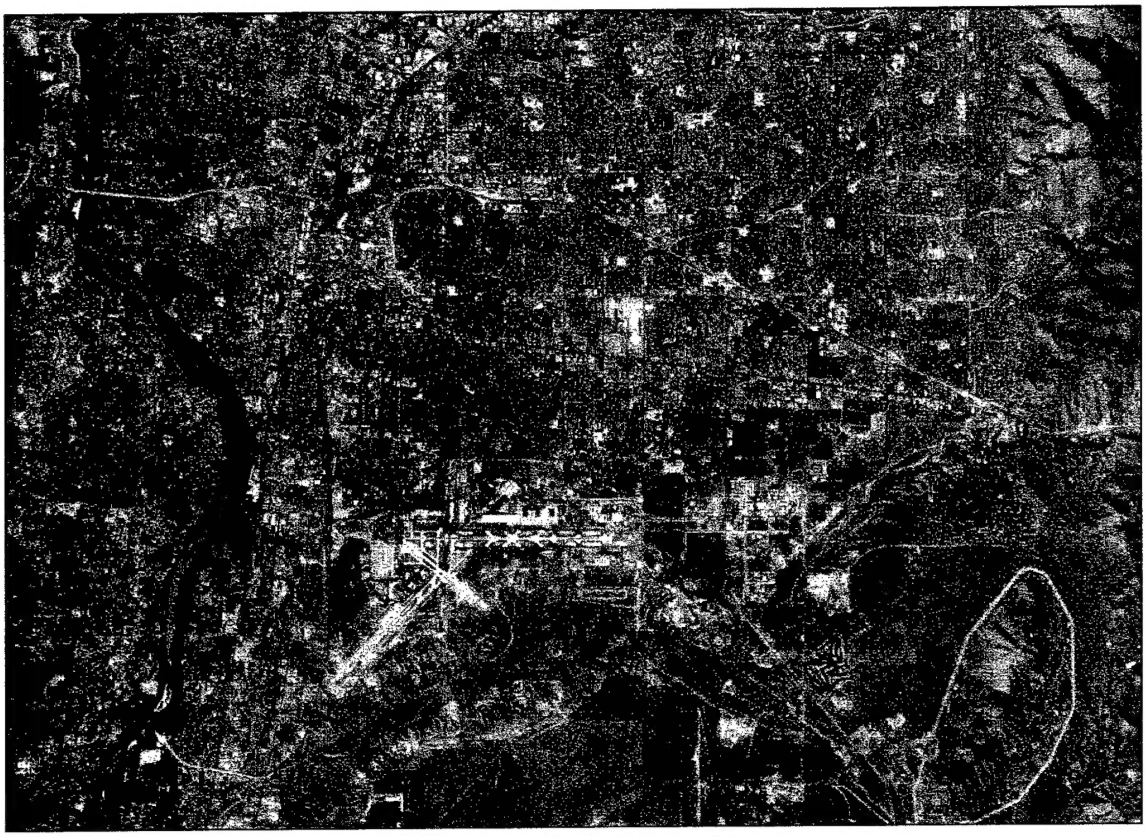


Figure 2: "Full map" coverage area of Kirtland AFB and Albuquerque, New Mexico. This composite aerial-photo is used at zoom level 3 in the simulation.

The maps as shown above are "scaled-down" so that the entire coverage area fits in the picture. In the simulation, the maps are displayed so that at zoom 1 each pixel represents 10 meters, at zoom 2 each pixel represents 5 meters, and at zoom 3, each pixel represents 1.25 meters.

Examples of the actual displays:

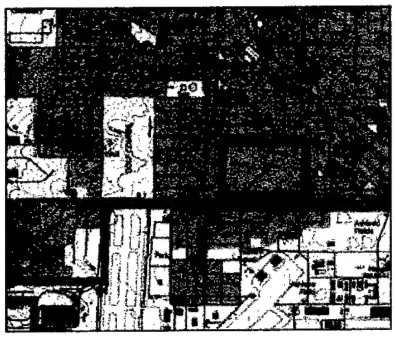


Figure 3: Zoom 1 display.

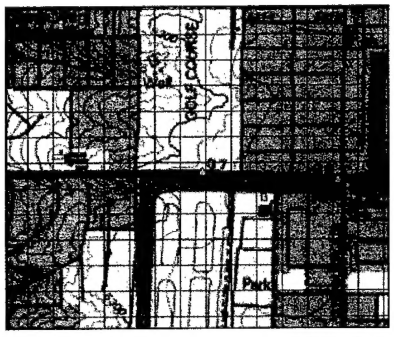


Figure 4: Zoom 2 display.

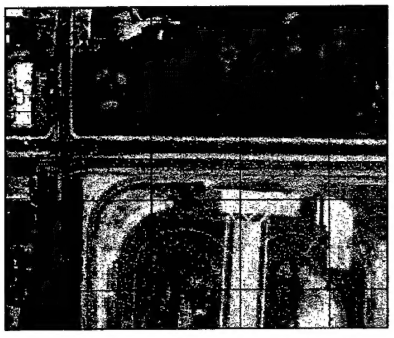


Figure 5: Zoom 3 display.

Once the base maps were digitized, compiled, and formatted for the simulation, the terrain and elevation data was entered to accurately model movement, cover, concealment, protection, and other effects. This was accomplished by dividing the map area into discrete "locations", where a location is defined as the smallest discrete amount of area, either on-map or off, which can be accessed by the simulation for any purpose. In board games, as well as most other computer games, it is known as a "hex". A unit is always

assumed to "fit" completely within a location, although the position of its "center of mass" is calculated to the nearest meter within that location. Terrain, other than linear features, is also considered evenly distributed throughout a location.

Each location measures 100 meters by 100 meters. These locations are visible as the gray "square outlines" on the sample zoom level 2 and 3 maps above.

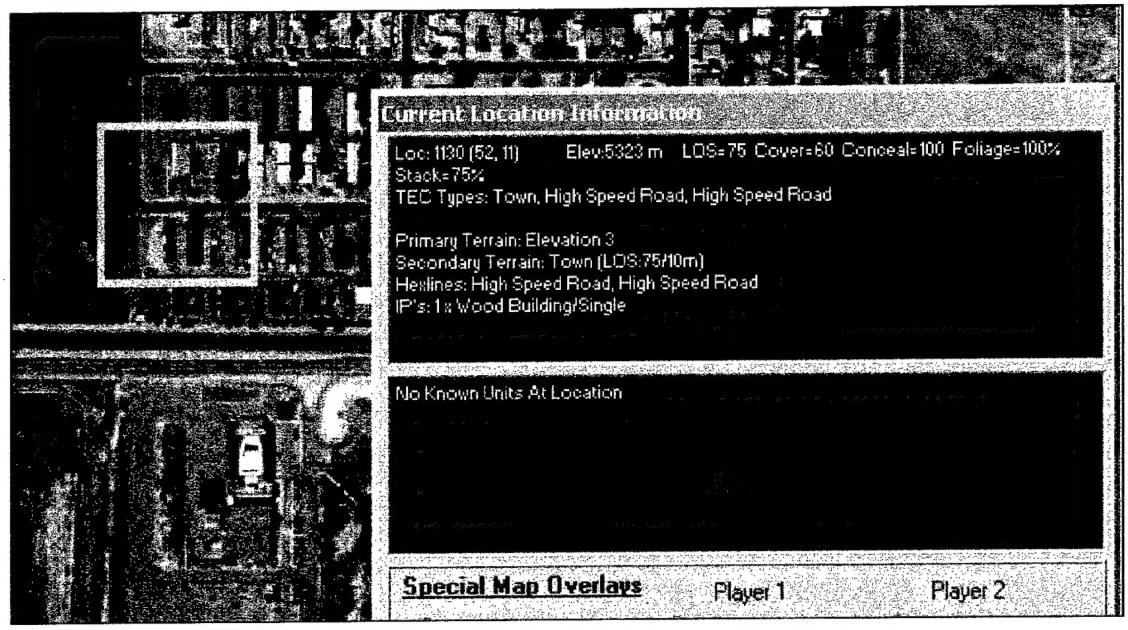


Figure 6: Sample of the elevation and multiple terrain types assigned to a location (identified by the gray square to the left on the map).

In practice, the complete map of the Kirtland AFB and Albuquerque area proved too big for the current generation of personal computers to handle efficiently with the RAM, CPU power, and overall processing speeds available to them. Therefore, two smaller "areas of interest" sub-maps were broken out for use with the actual scenarios. The sub-map areas are shown below.

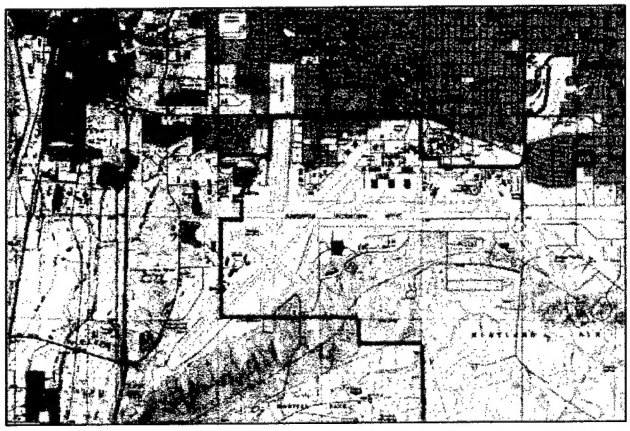


Figure 7: Kirtland AFB Sub-map #1.

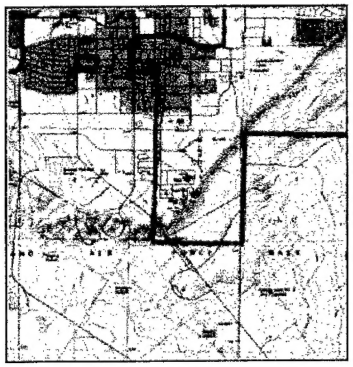


Figure 8: Kirtland AFB Sub-map #2.

A complete list of all terrain types is found in Appendix A.

3.2. Enter an assortment of conventional and non-conventional weapons into the software database, including HPM and other energy weapons, from unclassified information.

All of the weapons, vehicles, and other systems used by both friendly and enemy forces were researched and entered into the databases. These included conventions weapons, such as rifles, machine guns, grenades, and explosive charges, as well as advanced /directed energy weapons systems.

Buildings, including command bunkers and other protective structures and obstacles and barriers, including fences, barbed wire, concrete blocks, and related items were also defined.

Because of the nature of terror and other attacks carried out on physical targets in an "asymmetric" fashion, it was also necessary to create various types of civilians, and have them controlled with the computer AI. Civilians can be targets for the attackers, as well as acting as both a means of concealment, or even as "human shields" during an engagement. For the defenders, civilians are always impediments, sometimes significantly so, in that at the very least they limit movement and fields of fire.

A complete list of weapons systems is found in Appendix B, and a complete list of Advanced/Directed Energy weapons is found in Appendix C.

3.3. Develop several scenarios of terrorist attacks on the base.

Two reasonably plausible attack scenarios were prepared to demonstrate how the computer software models engagements, and to judge the software's overall effectiveness. These two scenarios, described below, were created without the use of classified information.

In the first scenario the attacking forces are comprised of:

- four terrorist squads on foot armed with light automatic weapons.
- a suicide car bomber, a suicide truck bomber.
- a reconnaissance section armed with AK-47's and grenades.
- a stolen US Army M-THEL laser (truck-mounted).

The defenders are:

- An Air Police Platoon consisting of a HQ element and 3 HMMV-mounted sections.
- A Stryker security detachment

The potential terrorist targets are:

- several aircraft parked on the apron
- a main command and communication bunker
- a large office/building complex

The starting situation appears as shown below, where the blue dots represent the defending USAF Air Police units and the red dots are terrorists or civilians (at first the defenders can't tell the difference).

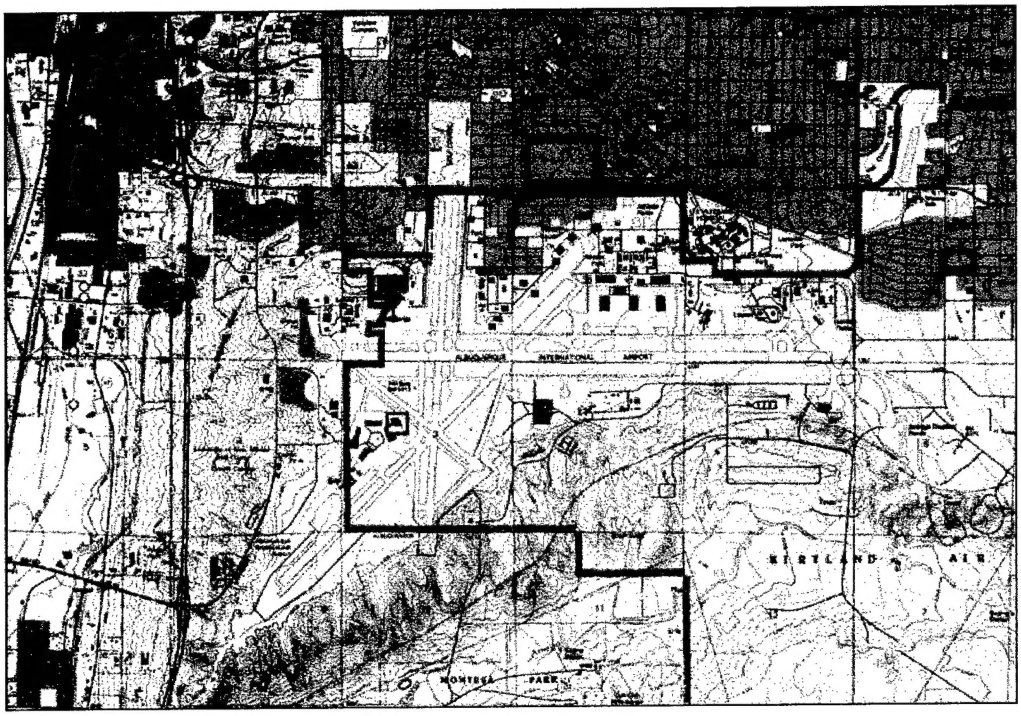


Figure 9: Kirtland AFB Scenario #1 (at start).

The second scenario occurs on the Eastern side of the base. In this scenario the attacking forces are comprised of:

- four terrorist squads on foot armed with light automatic weapons.
- a suicide car bomber, a suicide truck bomber.
- a platoon of "technical" trucks (pickup trucks with machine gun mounts).
- four reconnaissance units armed with AK-47's and grenades.

The defenders are:

- An Air Police Platoon consisting of a HQ element and 3 HMMV-mounted sections.
- A Stryker security detachment
- A section equipped with truck-mounted non-lethal MASER weapons.

The potential terrorist targets are:

- communications tower.
- a school.
- a large office/building complex.

The starting situation appears as shown below, where as with Scenario #1 the blue dots represent the defending USAF Air Police units and the red dots are terrorists or civilians.

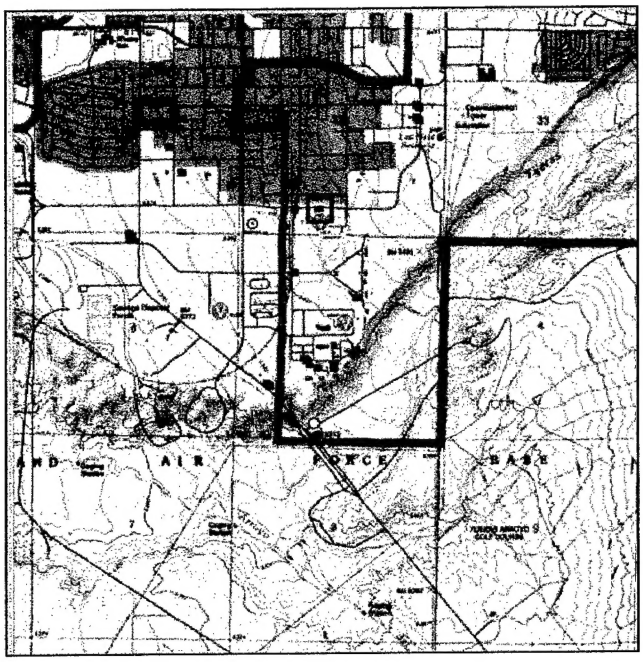


Figure 10: Kirtland AFB Scenario #2 (at start).

The default terrorist units were created using the DataView TO&E editor, as follows:

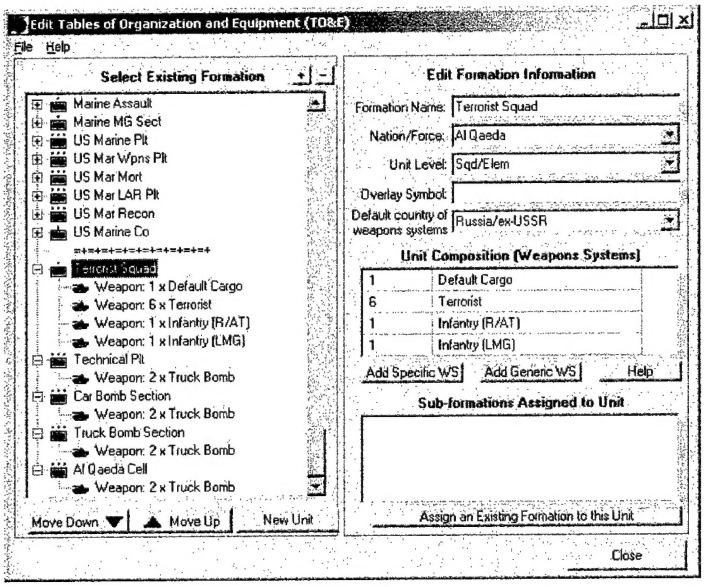


Figure 11: The default terrorist units created for the research scenarios. Users may freely edit and/or create units as they see fit.

3.4. Allow for government users to edit the weapons values, using classified or other data.

A series of easy-to-use data editors were constructed that allow government users to modify existing weapons and other systems, or to create their own from scratch. The original version contains no classified data, so this capability insures maximum flexibility and realism for users with access to that level of data.

The data editor, called the "DataView Module", allows customization and editing of all the data tables, including those defining weapons systems, ammunition types, advanced/energy weapons, armor types, as well as forces, units and structures. The main form appears as:

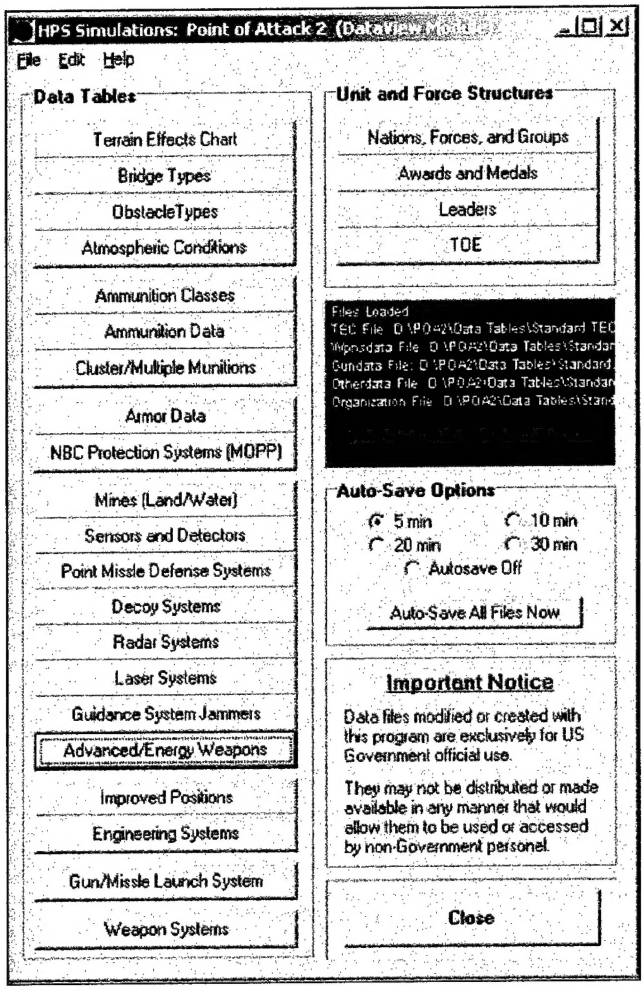


Figure 12: The Point of Attack DataView Module main screen.

Between all of the tables, there are several thousand unique data fields. Since the software has been provided to the Government, it is not beneficial to list all of the fields in this report. However, a sample data editing form is shown below for Weapons Systems:

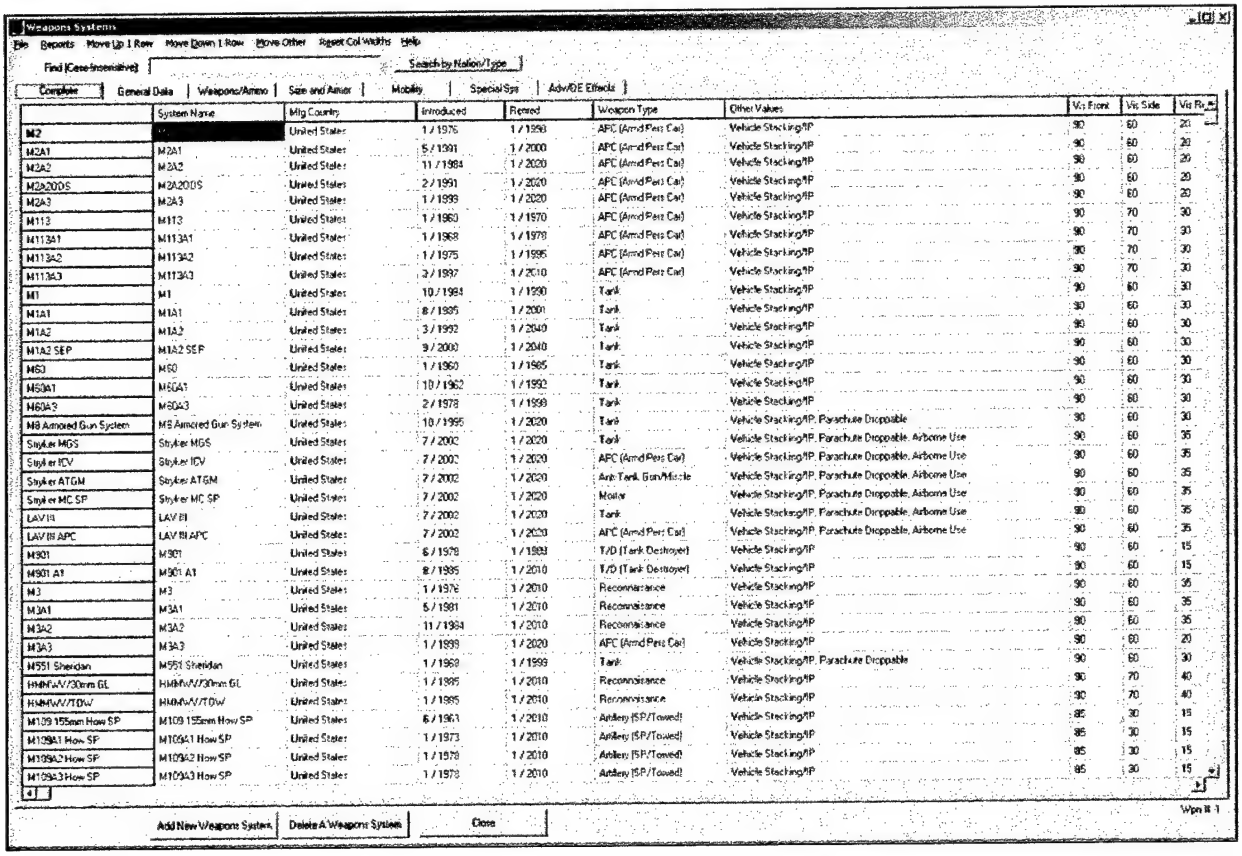
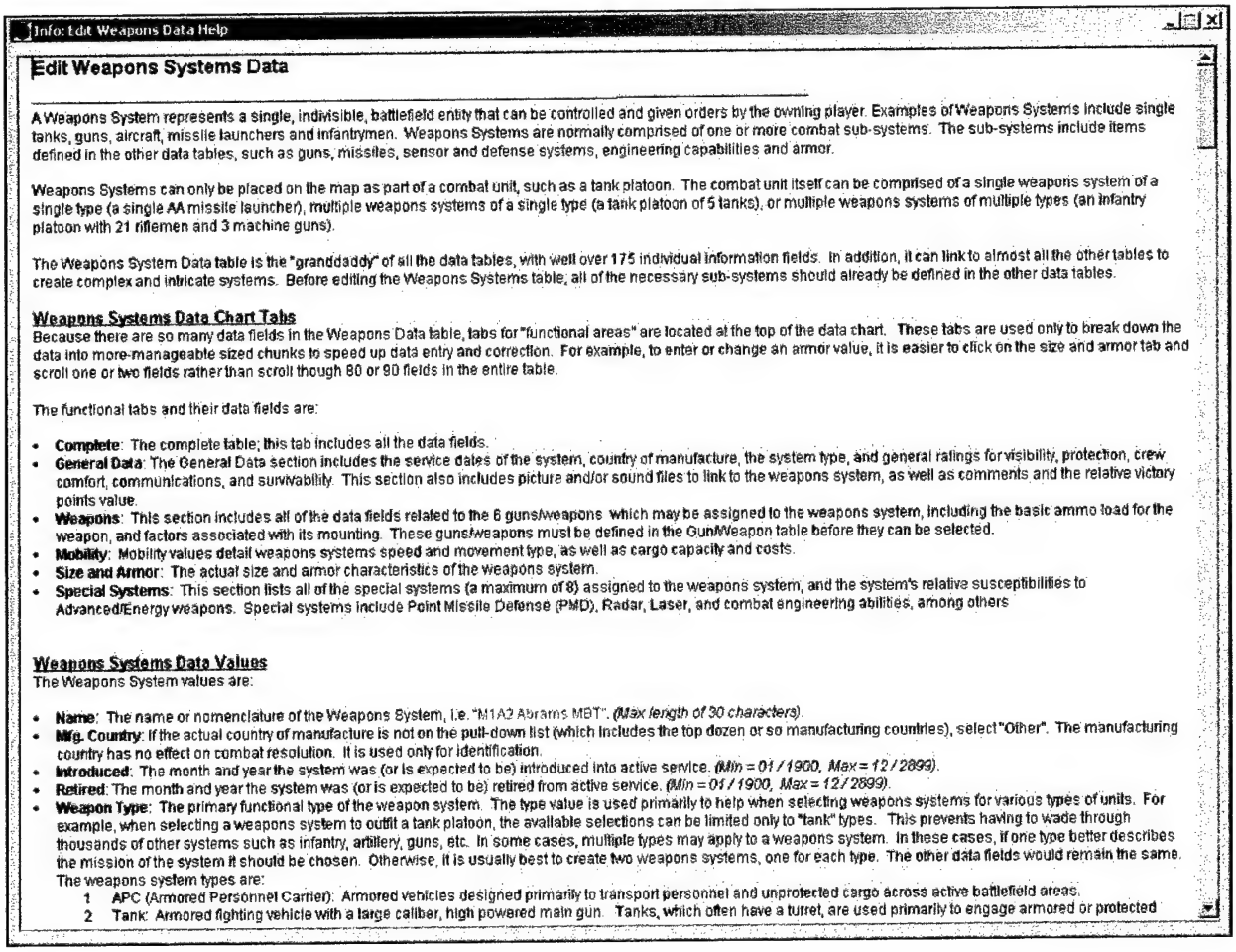


Figure 13: Sample Point of Attack -2 DataView form (for Weapons Systems).

Each data editing form also has an associated help file, which informs users of what the values mean, how they are used in the simulation, and if they are limited to a certain range.


Info: Edit Weapons Data Help

Edit Weapons Systems Data

A Weapons System represents a single, indivisible, battlefield entity that can be controlled and given orders by the owning player. Examples of Weapons Systems include single tanks, guns, aircraft, missile launchers and infantrymen. Weapons Systems are normally comprised of one or more combat sub-systems. The sub-systems include items defined in the other data tables, such as guns, missiles, sensor and defense systems, engineering capabilities and armor.

Weapons Systems can only be placed on the map as part of a combat unit, such as a tank platoon. The combat unit itself can be comprised of a single weapons system of a single type (a single AA missile launcher), multiple weapons systems of a single type (a tank platoon of 5 tanks), or multiple weapons systems of multiple types (an infantry platoon with 21 riflemen and 3 machine guns).

The Weapons System Data table is the "granddaddy" of all the data tables, with well over 175 individual information fields. In addition, it can link to almost all the other tables to create complex and intricate systems. Before editing the Weapons Systems table, all of the necessary sub-systems should already be defined in the other data tables.

Weapons Systems Data Chart Tabs

Because there are so many data fields in the Weapons Data table, tabs for "functional areas" are located at the top of the data chart. These tabs are used only to break down the data into more-manageable sized chunks to speed up data entry and correction. For example, to enter or change an armor value, it is easier to click on the size and armor tab and scroll one or two fields rather than scroll though 80 or 90 fields in the entire table.

The functional tabs and their data fields are:

- **Complete**: The complete table; this tab includes all the data fields.
- **General Data**: The General Data section includes the service dates of the system, country of manufacture, the system type, and general ratings for visibility, protection, crew comfort, communications, and survivability. This section also includes picture and/or sound files to link to the weapons system, as well as comments and the relative victory points value.
- **Weapons**: This section includes all of the data fields related to the 6 guns/weapons which may be assigned to the weapons system, including the basic ammo load for the weapon, and factors associated with its mounting. These guns/weapons must be defined in the Gun/Weapon table before they can be selected.
- **Mobility**: Mobility values detail weapons systems speed and movement type, as well as cargo capacity and costs.
- **Size and Armor**: The actual size and armor characteristics of the weapons system.
- **Special Systems**: This section lists all of the special systems (a maximum of 8) assigned to the weapons system, and the system's relative susceptibilities to Advanced/Energy weapons. Special systems include Point Missile Defense (PMD), Radar, Laser, and combat engineering abilities, among others

Weapons Systems Data Values

The Weapons System values are:

- **Name**: The name or nomenclature of the Weapons System, i.e. "M1A2 Abrams MBT". *(Max length of 30 characters)*.
- **Mfg. Country**: If the actual country of manufacture is not on the pull-down list (which includes the top dozen or so manufacturing countries), select "Other". The manufacturing country has no effect on combat resolution. It is used only for identification.
- **Introduced**: The month and year the system was (or is expected to be) introduced into active service. *(Min = 01 / 1900, Max = 12 / 2899)*.
- **Retired**: The month and year the system was (or is expected to be) retired from active service. *(Min = 01 / 1900, Max = 12 / 2899)*.
- **Weapon Type**: The primary functional type of the weapon system. The type value is used primarily to help when selecting weapons systems for various types of units. For example, when selecting a weapons system to outfit a tank platoon, the available selections can be limited only to "tank" types. This prevents having to wade through thousands of other systems such as infantry, artillery, guns, etc. In some cases, multiple types may apply to a weapons system. In these cases, if one type better describes the mission of the system it should be chosen. Otherwise, it is usually best to create two weapons systems, one for each type. The other data fields would remain the same. The weapons system types are:
  1. APC (Armored Personnel Carrier): Armored vehicles designed primarily to transport personnel and unprotected cargo across active battlefield areas.
  2. Tank: Armored fighting vehicle with a large caliber, high powered main gun. Tanks, which often have a turret, are used primarily to engage armored or protected

Figure 14: A sample data editor help form (for Weapons Systems).

3.5. Adjust the damage calculations as necessary to achieve accurate results for all weapons systems.

Because the data for some weapons systems was classified or unknown, some initial value entries were based on estimates. This was especially true for the advanced/energy weapons, but also for modern tank and missile rounds. However, by judging the results in the Kirtland scenarios along with about a dozen others, weapon performance and protection values were adjusted to achieve what were deemed reasonable results.

The simulation also provides a variety of other methods to check performance in the context of limited one-on-one engagements. The DataView module includes diagnostic tools for both ammunition and armor types, which shows the expected performance of specific munitions against specific targets. As an example, the following performance could be expected from an M829A2 Abrams main gun round:

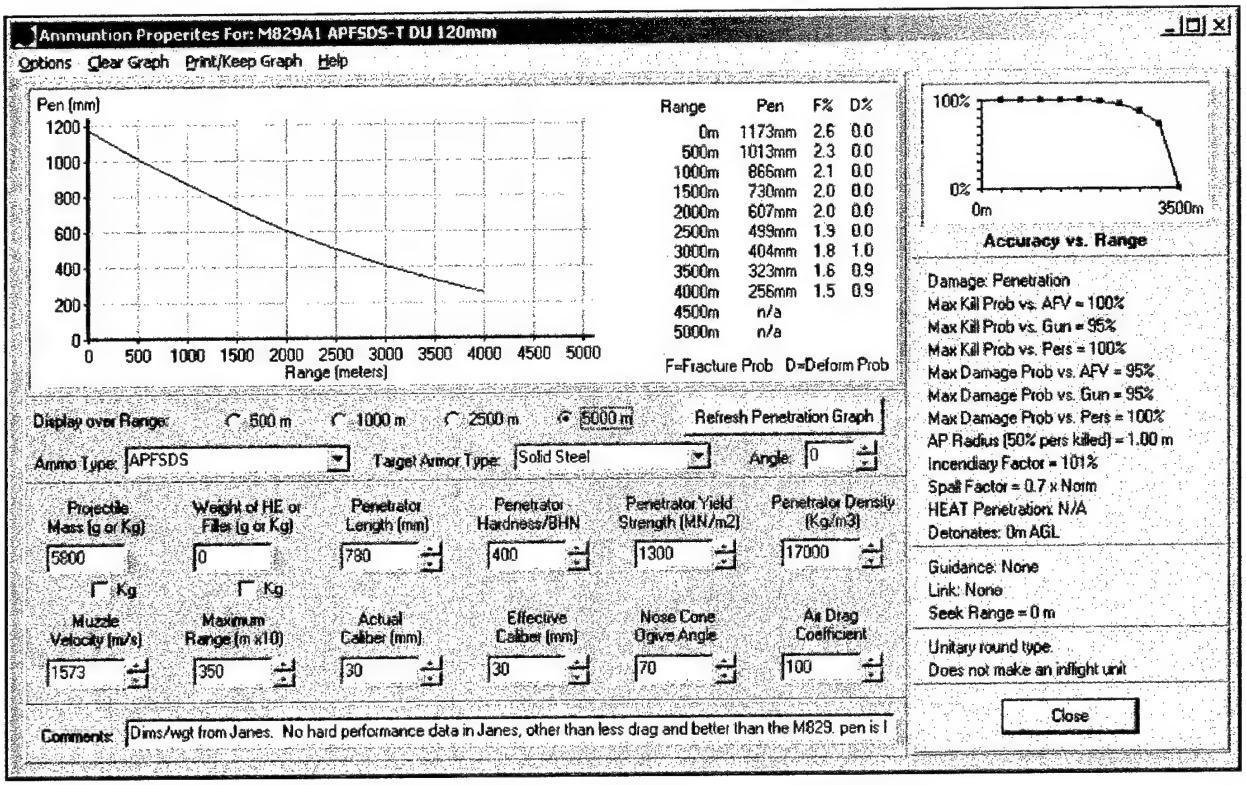


Figure 15: Sample performance data for M829A2 ammunition. Data includes penetration, fracture and deformation probabilities, as well as other values.

Additionally, in the simulation itself, expected accuracy and damage probabilities are provided during the targeting process, as shown in the example below. In this case an Air Police unit equipped with HMMV's is targeting a truck bomber with a .50 cal machine gun.

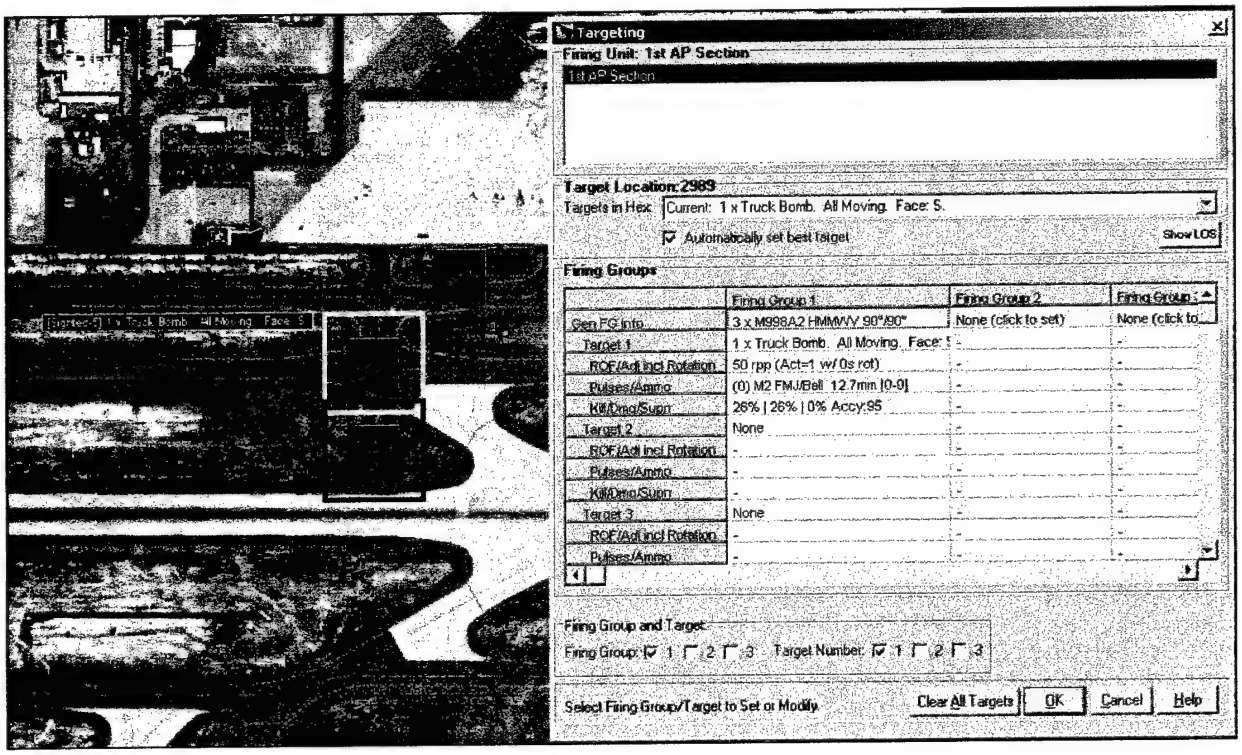


Figure 16: Targeting example. Note that the accuracy and kill, damage, and suppression values are shown (based on the ammunition fired and the characteristics and situation of the units involved).

At the end of a scenario, a final report is issued showing the losses on each side, as well as if the attacker achieved his objective.

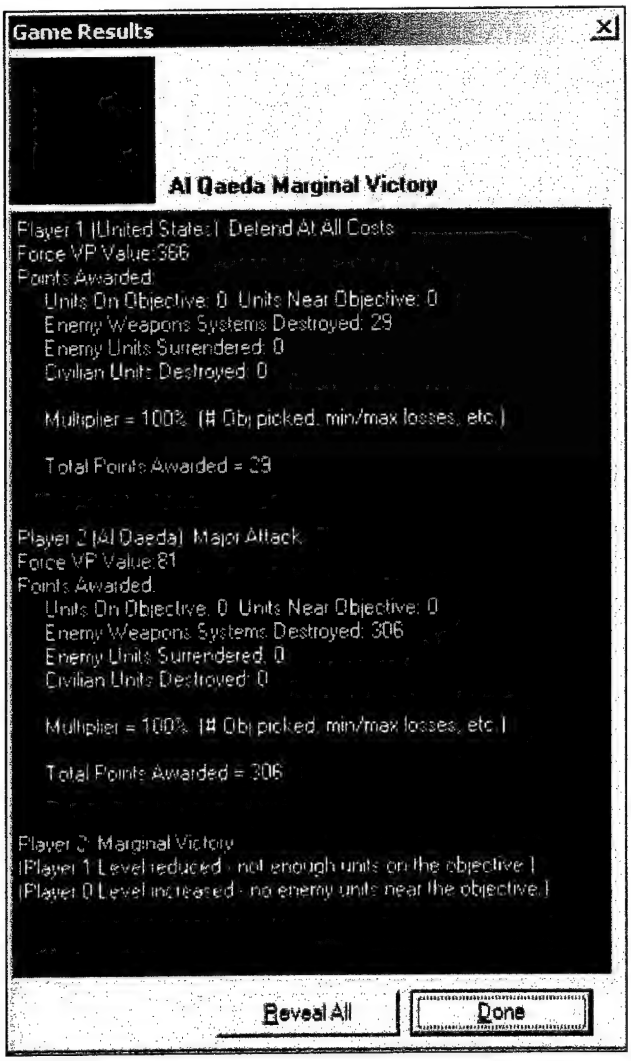


Figure 17: Final report showing the results of the scenario action.

The scenarios, maps, and data tables described in this report are included on the Point of Attack -2 production CD, which is available to all official US Government users.

4. Suggestions for Future Use

The US Government has the license to use the Point of Attack -2 software freely. While it can be used to model any combat situation, the results of this effort have shown that it is also flexible enough to accurately model terrorist and other non-conventional attacks. From the research encompassed by this project, the simulation can be expected to deliver realistic results. So various strategies can be developed, based upon any number of threat analysis contingencies.

However, what we feel is more important, is that running simulations of these types of attacks provides users with a wide range of insights that can not be gained in any other way. The interaction of civilians within a scenario is a prime example, especially at time of high density ("rush hour"). Because of the random nature of the civilian input and the ability and inclination of the enemy to exploit it, it is not possible to define exact strategies. But, by running scenarios like this in the simulation, the defense

teams can gain an appreciation of the potential effects of civilians on both the enemy's and their own responses, as well as the risk of causing collateral damage in attempting to destroy the threat.

Truly, forewarned is forearmed, and in situations where so many innocent lives can be at stake, and split-second decisions will be the rule, preparation though the use of the simulation is time well spent.

While the simulation is more than adequate to model the terrorist scenarios developed, the research highlighted two primary areas in which it can be improved. The first is to improve the AI (artificial intelligence) of the computer to better formulate plans and control units from the un-conventional attacker's perspective. The current AI is extremely "goal oriented", and it will usually attempt to move directly on the objective. In real-life, however, the attackers would probably make heavy use of civilians for masking, protection, and even as hostages. They might also be expected to take less direct paths that would reduce their exposure of being observed and detected.

Which leads directly to the second area of potential improvement, which concerns detecting the terrorists in the first place. Currently, the defending forces probably visually identify the terrorists too easily. By their very nature terrorists will dress and act in ways to "blend in" with the general population. So, detection requires other methods not modeled, including for example telephone intercepts, bomb detection by "sniffing" or close inspection at traffic stops. These new methods will need to supplant the current sighting and detection routines, which are not really appropriate for these types of attackers.

5. Personnel Involved

The following personnel contributed to the project:

Scott S. Hamilton: Research, database and model development, and programming.
Jeff Lapkoff: Programming.
Gregory M. Smith: Research and weapon effect analysis.
John C. Kincaid: Research, database entry, and testing.
Nicholas Bell: Map conversion and graphics, terrain entry, weapon effect analysis, and testing.
Joe Amoral: Artwork.

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Appendix A: Complete List of Terrain Types

- Open
- Meadow
- Plowed Field
- Desert
- Rough
- Rocky
- Rocky Desert
- Shallow Water
- Shallow Draft Water
- Deep Water
- Frozen Water
- Glacier
- Bog
- Swamp
- Marsh
- Sand/Beach
- Sand/Desert
- Sand Dunes/Loose
- Scrub
- Terrace
- Orchard
- Vineyard
- Treeline
- Scattered Trees
- Light Woods
- Woods
- Forest
- Jungle
- 1 Story Light Building
- 2 Story Light Building
- 2 Story Medium Building
- 2 Story Light Buildings
- 2 Story Medium Buildings
- Heavy Building
- City
- Town
- Village
- Large Storage Tanks
- Crops (Medium Height)
- Crops (Tall Height)
- Rice Paddy
- Craters/Light
- Craters/Med
- Craters/Heavy
- Rubble/Light
- Rubble/Med
- Rubble/Heavy
- Abatis
- Tetrahedron
- Dragon's Teeth
- Log Hurdles
- Log Crib
- Anti-Tank Ditch
- Berm
- Road Crater
- Wire (Tanglefoot)
- Wire (Concertina)
- Wire (Apron)
- Trail
- Low Speed Road
- High Speed Road
- Railroad
- River Ford
- River
- Stream
- Small Stream
- Ditch
- Hedge
- Hedgerow
- Fence
- Wall (Low Masonry)
- Wall (High Masonry)
- Embankment (low)
- Embankment (high)
- Infantry IP 1
- Infantry IP 2
- Infantry IP 3
- Infantry IP w/overhead cover 1
- Infantry IP w/overhead cover 2
- Infantry IP w/overhead cover 3
- Bunker (earth/log) 1
- Bunker (earth/log) 2
- Bunker (earth/log) 3
- Pillbox (concrete) 1
- Pillbox (concrete) 2
- Pillbox (concrete) 3
- Gun Emplacement 1
- Gun Emplacement 2
- Gun Emplacement 3
- Trench 1
- Trench 2
- Trench 3
- Lane
- Gap
- AP Minefield
- AT Minefield
- Vehicle Emplacement 1
- Vehicle Emplacement 2
- Vehicle Emplacement 3
- Aircraft Revetment
- Personnel Shelter 1
- Personnel Shelter 2
- Personnel Shelter 3
- Deep Water Barrier
- Shallow Draft Water Barrier
- Shallow Water Barrier
- Large Ditch
- Steep Embankment
- Cliff
- Sewer
- Tunnel
- Storm Drainage Canal

Appendix B: Complete List of Weapons Systems

- M2 (United States 1976)
- M2A1 (United States 1981)
- M2A2 (United States 1984)
- M2A2ODS (United States 1991)
- M2A3 (United States 1999)
- M113 (United States 1960)
- M113A1 (United States 1968)
- M113A2 (United States 1975)
- M113A3 (United States 1987)
- M1 (United States 1984)
- M1A1 (United States 1985)
- M1A2 (United States 1992)
- M1A2 SEP (United States 2000)
- M60 (United States 1960)
- M60A1 (United States 1962)
- M60A3 (United States 1978)
- M8 Armored Gun System (United States 1995)
- Stryker MGS (United States 2002)
- Stryker ICV (United States 2002)
- Stryker ATGM (United States 2002)
- Stryker MC SP (United States 2002)
- LAV III (United States 2002)
- LAV III APC (United States 2002)
- M901 (United States 1978)
- M901 A1 (United States 1985)
- M3 (United States 1976)
- M3A1 (United States 1981)
- M3A2 (United States 1984)
- M3A3 (United States 1999)
- M551 Sheridan (United States 1968)
- HMMWV/30mm GL (United States 1985)
- HMMWV/TOW (United States 1985)
- M109 155mm How SP (United States 1963)
- M109A1 How SP (United States 1973)
- M109A2 How SP (United States 1978)
- M109A3 How SP (United States 1978)
- M109A4 How SP (United States 1978)
- M109A5 How SP (United States 1978)
- M109A6 How SP (United States 1988)
- M107 175mm SP (United States 1961)
- M110 203mm SP (United States 1961)
- M110A1 SP (United States 1976)
- M110A2 SP (United States 1982)
- M119 105mm towed (United States 1989)
- M198 155mm towed (United States 1979)
- CUCV 4x4 (United States 1983)
- M54 5T (United States 1950)
- M813 5T (United States 1970)
- M992 FAASV (United States 1985)
- M35A3 2.5T (United States 1996)
- M998 HMMWV (United States 1985)
- M998A1 HMMWV (United States 1993)
- M998A2 HMMWV (United States 1993)
- M151 JEEP (United States 1960)
- M548 Cargo (United States 1966)
- M923 5T (United States 1983)
- M977 HEMTT (United States 1983)
- BSFV / Stinger (United States 1996)
- M730A2 CHAPARRAL (United States 1980)
- M163A1/VULCAN (United States 1970)
- HMMWV Avenger (United States 1989)
- M192 Hawk SAM Carrier (United States 1960)
- M860 Patriot SAM Carrier (United States 1990)
- M125 SP (United States 1960)
- M125A1 SP (United States 1960)
- M125A2 SP (United States 1978)
- M106 SP (United States 1960)
- M106A1 SP (United States 1960)
- M106A2 SP (United States 1975)
- M1064A3 SP (United States 1996)
- M19 60mm (United States 1950)
- M224 60mm (United States 1981)
- M224 60mm (Abn) (United States 1981)
- M29 81mm (United States 1960)
- M29A1 81mm (United States 1970)
- M252 81mm (United States 1987)
- M30 4.2" (United States 1960)
- M120 120mm (United States 1991)
- M270A1 MLRS Launcher (United States 1982)
- TPQ-36 / HMMWV (United States 1993)
- TPQ-37 Firefinder (United States 1990)
- F-14D Tomcat (Attack) (United States 1993)
- F-14D Tomcat (Interceptor) (United States 1993)
- F/A-18C/D Hornet (Interceptor) (United States 1983)
- F/A-18C/D Hornet (Night Attack) (United States 1989)
- F-22 Raptor (Interceptor) (United States 2000)
- F-15C Eagle (Interceptor) (United States 1975)
- F-15E Eagle (Attack) (United States 1975)
- F-16C Falcon (Attack) (United States 1979)
- F-111F Aardvark (United States 1969)
- A-10 Thunderbolt (United States 1977)
- A-6E Intruder (United States 1972)
- AV-8B Harrier (United States 1985)
- AC-130 Spectre (United States 1967)
- C-130 w/Bomb (United States 1967)
- B-1B Lancer (United States 1986)
- B-2 Spirit (United States 1994)
- B-52H Stratofortress (United States 1955)
- E-2C Hawkeye/AEWC (United States 1997)
- E-3 Sentry/AWACS (United States 1976)
- EA-6B Prowler (United States 1971)
- EF-111A Raven (United States 1982)
- RC-12 Guardrail (United States 1983)
- F-117A Nighthawk (United States 1983)
- M1A2/PLOW (United States 1992)
- M1A2/ROLLER (United States 1992)
- VOLCANO Minelayer (United States 1966)
- M113A3/MICLIC (United States 1987)
- M1A2 Dozer Blade (United States 1992)
- M1 AVLB (United States 1996)
- M60 AVLB (United States 1962)
- M9 ACE (United States 1989)
- M88A1 ARV (United States 1977)
- M88A2 ARV (United States 2001)
- M728 CEV (United States 1968)
- D7G Dozer (United States 1989)
- M577 (United States 1963)
- M577 A1 (United States 1963)
- M577 A2 (United States 1978)
- M981 FIST V (United States 1985)
- M-7 Bradley FIST (United States 1999)
- M7A3 BCV (United States 2002)

- M4 Command Veh (United States 2001)
- M1068A3 (United States 1993)
- COMMAND POST (United States 1990)
- RADAR SITE (SI) (United States 1990)
- AH-1S COBRA (United States 1967)
- AH-1W SeaCobra (United States 1987)
- UH-1N HUEY (United States 1972)
- CH-46 Sea Knight (United States 1961)
- CH-47 Chinook (United States 1968)
- CH-53D Sea Stallion (United States 1966)
- CH-53E Super Stallion (United States 1981)
- OH-58D Kiowa Warrior (United States 1992)
- UH-60 BLACKHAWK (United States 1981)
- EH-60 ECM HELO (United States 1990)
- SH-60 Seahawk (United States 1991)
- HH-60H Seahawk (United States 1991)
- AH-64A APACHE (United States 1987)
- AH-64D APACHE (United States 1994)
- AH-64D APACHE/LONGBOW (United States 1987)
- AH-66 COMANCHE (United States 2007)
- RAH-66 Comanche (United States 2007)
- V-22 Osprey (United States 2000)
- RQ-1 Predator (United States 1995)
- AQ-1 Predator (United States 2001)
- Gnat 750 (United States 1996)
- Exdrone (United States 1998)
- Shadow 200 (United States 2001)
- Pioneer (United States 1990)
- Micro Air Vehicle (United States 2005)
- AAV7A1 (United States 1982)
- AAVC7A1 (United States 1971)
- AAVR7A1 (United States 1985)
- Infantry (R) (United States 1990)
- Infantry (R/AT) (United States 1990)
- Infantry (AR/SAW) (United States 1990)
- Infantry (Gren) (United States 1990)
- Infantry (AT) (United States 1990)
- Military Police (R) (United States 1990)
- Cbt Eng (United States 1990)
- Electronic Warfare Tm (United States 1990)
- Abn Inf (R) (United States 1990)
- Abn Inf (R/AT) (United States 1990)
- Abn Inf (AR/SAW) (United States 1990)
- Abn Inf (Gren) (United States 1990)
- Abn Infantry (AT) (United States 1990)
- Abn Cbt Eng (United States 1990)
- Ranger Inf (R) (United States 1990)
- Ranger Inf (R/AT) (United States 1990)
- Ranger Inf (MG) (United States 1990)
- Ranger Inf (Gren) (United States 1990)
- Delta Force (Russia/ex-USSR 1990)
- FFG-7 Class (United States 1977)
- DDG-51 Class (United States 1991)
- CVN-68 Class (United States 1975)
- Airborne HEL (ABL) (United States 2006)
- AC-130 Spectre w/THEL (United States 2010)
- M-THEL/Vehicle Mounted (United States 2010)
- V-22 Osprey w/HPM (United States 2010)
- AQ-1 Predator w/HPM (United States 2015)
- MASER/Truck mount (United States 1996)
- BMP-3 (Russia/ex-USSR 1990)
- BMP-2 export (Russia/ex-USSR 1980)
- BMP-2 (Russia/ex-USSR 1980)
- BMP-2D (Russia/ex-USSR 1982)
- BMP-2/KMT-10 (Russia/ex-USSR 1990)
- BMP-1 (Russia/ex-USSR 1967)
- BMP-1/KMT-10 (Russia/ex-USSR 1967)
- BMD-3 (Russia/ex-USSR 1990)
- BMD-2 (Russia/ex-USSR 1988)
- BMD-1 (Russia/ex-USSR 1969)
- BTR-D (Russia/ex-USSR 1979)
- MT-LB (Russia/ex-USSR 1970)
- BTR-90 (Russia/ex-USSR 1994)
- BTR-80A (Russia/ex-USSR 1994)
- BTR-80 (Russia/ex-USSR 1984)
- BTR-70 (Russia/ex-USSR 1978)
- BTR-70/AGS-17 (Russia/ex-USSR 1978)
- BTR-60P (Russia/ex-USSR 1960)
- BTR-60PA (Russia/ex-USSR 1963)
- BTR-60PB (Russia/ex-USSR 1963)
- BTR-T (Russia/ex-USSR 1996)
- GAZ-3937 (Russia/ex-USSR 1994)
- T-90 (Russia/ex-USSR 1994)
- T-84 (Russia/ex-USSR 1993)
- T-80 (Russia/ex-USSR 1976)
- T-80B (Russia/ex-USSR 1978)
- T-80BV (Russia/ex-USSR 1985)
- T-80U (Russia/ex-USSR 1985)
- T-80UD (Russia/ex-USSR 1988)
- T-80UM (Russia/ex-USSR 1993)
- T-72 (Russia/ex-USSR 1973)
- T-72 m1975 (Russia/ex-USSR 1975)
- T-72 A (Russia/ex-USSR 1979)
- T-72 M (Russia/ex-USSR 1980)
- T-72M1 (Russia/ex-USSR 1982)
- T-72 AV (Russia/ex-USSR 1985)
- T-72 B (Russia/ex-USSR 1985)
- T-72 B1 (Russia/ex-USSR 1985)
- T-72 S (Russia/ex-USSR 1987)
- T-72 S1 (Russia/ex-USSR 1987)
- T-72 BM (Russia/ex-USSR 1992)
- T-72 /PW-LWD (Russia/ex-USSR 1973)
- MTU-72 (Russia/ex-USSR 1975)
- T-64 (Russia/ex-USSR 1966)
- T-64A (Russia/ex-USSR 1969)
- T-64 B (Russia/ex-USSR 1974)
- T-64 BM (Russia/ex-USSR 1974)
- T-64 BV (Russia/ex-USSR 1984)
- T-64 B1 (Russia/ex-USSR 1981)
- T-64/KMT 4 (Russia/ex-USSR 1969)
- T-62 (Russia/ex-USSR 1962)
- T-62 m 1972 (Russia/ex-USSR 1972)
- T-62 m 1975 (Russia/ex-USSR 1975)
- T-62 D (Russia/ex-USSR 1975)
- TO-62 Flamethrower (Russia/ex-USSR 1975)
- T-62M (Russia/ex-USSR 1980)
- T-62M1 (Russia/ex-USSR 1980)
- T-62MV (Russia/ex-USSR 1980)
- T-55 (Russia/ex-USSR 1958)
- TO-55 Flamethrower (Russia/ex-USSR 1961)
- T-55M (Russia/ex-USSR 1983)
- T-55MV (Russia/ex-USSR 1983)
- T-55/BTU-55 Dozer (Russia/ex-USSR 1958)
- T-55/PT-55 Mineroller (Russia/ex-USSR 1958)
- MTU-20 (Russia/ex-USSR 1968)
- T-54 (Russia/ex-USSR 1953)
- OT-54 Flamethrower (Russia/ex-USSR 1955)
- T-54B (Russia/ex-USSR 1957)
- T-54M (Russia/ex-USSR 1983)

- BMP-3/Kornet (Russia/ex-USSR 1994)
- BMP-3/Khrizantema (Russia/ex-USSR 1996)
- MT-LB/Spiral (Russia/ex-USSR 1990)
- BRDM-2/Sagger (Russia/ex-USSR 1973)
- BRDM-2/Swatter C (Russia/ex-USSR 1973)
- BRDM-2/Spandrel (Russia/ex-USSR 1977)
- BRM (Russia/ex-USSR 1993)
- PRP-4 (Russia/ex-USSR 1975)
- PRP-3 (Russia/ex-USSR 1975)
- BRDM-2 (Russia/ex-USSR 1966)
- BRDM-2-RKhb (Russia/ex-USSR 1966)
- BRDM-1 (Russia/ex-USSR 1959)
- BRDM-1-RKhb (Russia/ex-USSR 1959)
- BTR-70Kh (Russia/ex-USSR 1978)
- RKhM-4-01 (Russia/ex-USSR 1984)
- ACRV (Russia/ex-USSR 1973)
- 2S23 120mm SP (Russia/ex-USSR 1990)
- 2S4 240mm SP (Russia/ex-USSR 1975)
- 2S7 203mm SP (Russia/ex-USSR 1975)
- 2S19 152mm SP (Russia/ex-USSR 1989)
- 2S5 152mm SP (Russia/ex-USSR 1976)
- 2S3 152mm SP (Russia/ex-USSR 1973)
- 2S3M 152mm SP (Russia/ex-USSR 1973)
- 2S1 122mm SP (Russia/ex-USSR 1973)
- 2S31 120mm SP (Russia/ex-USSR 1990)
- 2S9 120mm SP (Russia/ex-USSR 1985)
- S-23 180mm Towed (Russia/ex-USSR 1955)
- 2A65 152mm Towed (Russia/ex-USSR 1987)
- 2A36 152mm Towed (Russia/ex-USSR 1976)
- D-20 152mm Towed (Russia/ex-USSR 1955)
- 2A61 152mm Towed (Russia/ex-USSR 1993)
- M-46 130mm Towed (Russia/ex-USSR 1954)
- D-74 122mm Towed (Russia/ex-USSR 1955)
- D-30 122 mm Towed (Russia/ex-USSR 1962)
- M-30 122 mm Towed (Russia/ex-USSR 1938)
- 2B16 NONA-K 120mm Towed (Russia/ex-USSR 1986)
- 76mm GP Mtn Gun Towed (Russia/ex-USSR 1966)
- LuAZ-967M (Russia/ex-USSR 1964)
- LuAZ-969 (Russia/ex-USSR 1972)
- UAZ-469B (Russia/ex-USSR 1973)
- UAZ-3172 (Russia/ex-USSR 1978)
- GAZ-69AM (Russia/ex-USSR 1952)
- GAZ-66 4x4 (Russia/ex-USSR 1964)
- GAZ-3937 4x4 (Russia/ex-USSR 1995)
- ZIL-157 6x6 (Russia/ex-USSR 1958)
- ZIL-131 6x6 (Russia/ex-USSR 1966)
- Ural-375D 6x6 (Russia/ex-USSR 1961)
- KAMAZ-4350 4x4 (Russia/ex-USSR 1990)
- Ural-4325 4x4 (Russia/ex-USSR 1978)
- Ural-4320 6x6 (Russia/ex-USSR 1978)
- ZIL-130 4x2 (Russia/ex-USSR 1964)
- KAMAZ-5350 6x6 (Russia/ex-USSR 1990)
- Ural-377 6x4 (Russia/ex-USSR 1965)
- KrAZ-255B 6x6 (Russia/ex-USSR 1979)
- KAMAZ-5320 6x4 (Russia/ex-USSR 1990)
- KrAZ-260 6x6 (Russia/ex-USSR 1979)
- KAMAZ-6350 8x8 (Russia/ex-USSR 1990)
- BAZ-135L4 8x8 (Russia/ex-USSR 1965)
- BAZ-5937 6x6 amph (Russia/ex-USSR 1990)
- 2S6 30mm/SA-19 SP (Russia/ex-USSR 1986)
- SA-4b Ganef SP (Russia/ex-USSR 1968)
- SA-6b Gainful SP (Russia/ex-USSR 1967)
- SA-8b Gecko SP (Russia/ex-USSR 1975)
- SA-9 Gaskin SP (Russia/ex-USSR 1968)
- SA-11 Gadfly SP (Russia/ex-USSR 1975)
- SA-12A Gladiator SP (Russia/ex-USSR 1986)
- SA-12B Giant SP (Russia/ex-USSR 1988)
- SA-13 Gopher SP (Russia/ex-USSR 1988)
- SA-17 Grizzly SP (Russia/ex-USSR 1995)
- ZU-23 SP (Russia/ex-USSR 1965)
- ZSU-23-4 SP (Russia/ex-USSR 1965)
- S-60 57mm AA SP (Russia/ex-USSR 1953)
- 2B9 Vasilyek auto 82 mm (Russia/ex-USSR 1971)
- M-36 82mm (Russia/ex-USSR 1936)
- M-37 82mm (Russia/ex-USSR 1937)
- M-41 82mm (Russia/ex-USSR 1941)
- 2B14 82mm (Russia/ex-USSR 1985)
- M-38 107mm (Russia/ex-USSR 1938)
- M-43 120mm (Russia/ex-USSR 1943)
- 2S11 120mm (Russia/ex-USSR 1952)
- Nona SVK-M 120mm (Russia/ex-USSR 1990)
- M-43 160 mm (Russia/ex-USSR 1943)
- M-160 160mm (Russia/ex-USSR 1970)
- M-240 240 mm (Russia/ex-USSR 1953)
- FROG-7 SP (Russia/ex-USSR 1964)
- BM 9A52 300mm SP (Russia/ex-USSR 1983)
- BM-27 220mm SP (Russia/ex-USSR 1975)
- BM 9A51 122mm SP (Russia/ex-USSR 1987)
- BM-21 122mm SP (Russia/ex-USSR 1963)
- BM-21V 122mm SP (Russia/ex-USSR 1975)
- 2A45M Sprut-B 125mm Towed (Russia/ex-USSR 1988)
- MT-12 100mm Towed (Russia/ex-USSR 1965)
- T-12 100mm Towed (Russia/ex-USSR 1960)
- D-44 85mm Towed (Russia/ex-USSR 1945)
- SD-44 85mm Towed (Russia/ex-USSR 1945)
- IL-20DSR "Coot" sensor recon (Russia/ex-USSR 1977)
- IL-76MD "Candid-B" (Russia/ex-USSR 1975)
- MiG-21P "Fishbed-D" (Russia/ex-USSR 1958)
- MiG-21R "Fishbed-H" (Russia/ex-USSR 1959)
- MiG-23S "Flogger-A" (Russia/ex-USSR 1971)
- MiG-23M "Flogger-B" (Russia/ex-USSR 1975)
- MiG-23BN "Flogger-F" (Russia/ex-USSR 1970)
- MiG-23ML "Flogger-G" (Russia/ex-USSR 1976)
- MiG-25P "Foxbat-A" (Russia/ex-USSR 1965)
- MiG-25R "Foxbat-B" (Russia/ex-USSR 1965)
- MiG-27D "Flogger-J2" (Russia/ex-USSR 1980)
- MiG-29SMT "Fulcrum-D" (Russia/ex-USSR 1998)
- MiG-31 "Foxhound-A" (Russia/ex-USSR 1982)
- MiG-31M "Foxhound-B" (Russia/ex-USSR 1992)
- Su-17M-3 "Fitter-H" (Russia/ex-USSR 1972)
- Su-24M "Fencer-D" (Russia/ex-USSR 1977)
- Su-24MP "Fencer-F" (EW) (Russia/ex-USSR 1985)
- Su-25 "Frogfoot" (Russia/ex-USSR 1989)
- Su-27 "Flanker-B" Fighter (Russia/ex-USSR 1991)
- Su-27 "Flanker-B" Interceptor (Russia/ex-USSR 1985)
- Su-30 (Russia/ex-USSR 1992)
- Su-34 (Russia/ex-USSR 1992)
- Su-35 (Russia/ex-USSR 1994)
- Tu-16P "Badger-J" (Russia/ex-USSR 1964)
- Tu-95K-20 "Bear-B" (Russia/ex-USSR 1959)
- Tu-22K "Blinder-B" (Russia/ex-USSR 1961)
- Tu-22M-3 "Backfire-C" (Russia/ex-USSR 1983)

- Tu-160 "Blackjack" (Russia/ex-USSR 1988)
- Ka-27PL "Helix-A" (Russia/ex-USSR 1982)
- Ka-29TB "Helix-B" (Russia/ex-USSR 1989)
- Ka-50 "Hokum" (Russia/ex-USSR 1992)
- Mi-6 "Hook" (Russia/ex-USSR 1960)
- Mi-8T "Hip-C" (Russia/ex-USSR 1962)
- Mi-8TB "Hip-E" (Russia/ex-USSR 1964)
- Mi-8PPA "Hip-K" (Russia/ex-USSR 1962)
- Mi-24D "Hind-D" (Russia/ex-USSR 1973)
- Mi-24V "Hind-E" (Russia/ex-USSR 1976)
- Mi-24P "Hind-F" (Russia/ex-USSR 1981)
- Mi-26 "Halo" (Russia/ex-USSR 1983)
- Mi-28 "Havoc" (Russia/ex-USSR 1994)
- Mi-40 asslt trans (Russia/ex-USSR 2000)
- Ka-37 (Russia/ex-USSR 1998)
- Yak-61 Shmel (Russia/ex-USSR 1999)
- OT-54 Flame gun (Russia/ex-USSR 1953)
- T-62 Flame gun (Russia/ex-USSR 1962)
- TO-55 Flame gun (Russia/ex-USSR 1958)
- ATGW AT4 SPIGOT INF PORTABLE (Russia/ex-USSR 1985)
- ATGW AT5 SPANDREL INF PORTABLE (Russia/ex-USSR 1985)
- ATGW AT-X-14 KORNET INF PORTABLE (Russia/ex-USSR 1995)
- ATGW AT-3 SAGGER INF PORTABLE (Russia/ex-USSR 1973)
- 9K310 SAM-16 INF Weapon (Russia/ex-USSR 1981)
- 9T234 Transloader 300mm MLRS (Russia/ex-USSR 1983)
- T-80UK (Russia/ex-USSR 1978)
- T-72K (Russia/ex-USSR 1973)
- T-72 BK (Russia/ex-USSR 1985)
- T-64AK (Russia/ex-USSR 1969)
- T-64 BV1K (Russia/ex-USSR 1981)
- T-62MK (Russia/ex-USSR 1975)
- T-55MK (Russia/ex-USSR 1983)
- BRDM-2U (Russia/ex-USSR 1966)
- BRDM-U (Russia/ex-USSR 1959)
- BMP-3K (Russia/ex-USSR 1990)
- BMP-2K (Russia/ex-USSR 1980)
- BMP-1K (Russia/ex-USSR 1967)
- BMP-1KShM (Russia/ex-USSR 1967)
- BMD-KShM (Russia/ex-USSR 1967)
- MT-LBU (Russia/ex-USSR 1970)
- BTR-80K (Russia/ex-USSR 1984)
- BTR-80 M1989/1 (Russia/ex-USSR 1984)
- BTR-70KShM (Russia/ex-USSR 1978)
- BTR-60PBK (Russia/ex-USSR 1963)
- BTR-60PU (Russia/ex-USSR 1960)
- Infantry (R) (Russia/ex-USSR 1990)
- Infantry (R/AT) (Russia/ex-USSR 1990)
- Infantry (LMG) (Russia/ex-USSR 1990)
- Infantry (MG) (Russia/ex-USSR 1990)
- AGS-17 GL Team (Russia/ex-USSR 1990)
- Sniper (Russia/ex-USSR 1990)
- Air Defense Team (Russia/ex-USSR 1990)
- Cbt Eng (Russia/ex-USSR 1990)
- Spetznatz (Russia/ex-USSR 1990)
- Electronic Warfare Tm (Russia/ex-USSR 1990)
- Abn Infantry (R) (Russia/ex-USSR 1990)
- Abn Infantry (R/AT) (Russia/ex-USSR 1990)
- Abn Infantry (LMG) (Russia/ex-USSR 1990)
- Abn Sniper (Russia/ex-USSR 1990)
- Neustrashimy Class FFG (Russia/ex-USSR 1993)
- Sovremenny Class DDG (Russia/ex-USSR 1985)
- RADAR SITE (SF) (Russia/ex-USSR 1990)
- RADAR SITE (SR) (Russia/ex-USSR 1990)
- RADAR SITE (SN) (Russia/ex-USSR 1990)
- COMMAND POST (Russia/ex-USSR 1990)
- Temp; Small, Air (Pending) (All Countries 1990)
- Temp; Medium, Air (Pending) (All Countries 1990)
- Temp; Large, Air (Pending) (All Countries 1990)
- Temp; X Large, Air (Pending) (All Countries 1990)
- Temp; Small, Grnd (Pending) (All Countries 1990)
- Temp; Med, Grnd (Pending) (All Countries 1990)
- Phoenix (UK 1990)
- Hunter (Israel 1990)
- Fox AT (France 1990)
- Technical - MG (Other Country 1970)
- Terrorist (Other Country 1990)
- Guerrilla Forces (Other Country 1990)
- Civilian Refugees (Other Country 1983)
- Civilian Refugees (Auto) (Other Country 1983)
- Parked Jet Fighter (All Countries 1979)
- Parked Jet Bomber (All Countries 1986)
- Car Bomb (All Countries 1964)
- Truck Bomb (All Countries 1961)
- Marine (R) (United States 1990)
- Marine Asslt (AT) (United States 1990)
- Marine Inf (MG) (United States 1990)
- Marine Inf (Gren) (United States 1990)
- News Media (Other Country 1983)

Appendix C: Complete List of Advanced/Directed Energy Systems

- HEMP (Wide Band) - Nuclear High Alt
- SREMP (Wide Band) - Nuclear Low Alt
- SBEMP (Wide Band) - Nuclear Surface
- MASER - High Power
- MASER - Low Power (Non-Lethal)
- LASER - High Power Red
- LASER - High Power Gr/Blue
- LASER - High Power IR (MIRACL)
- LASER - Low Power/Blinding
- Particle Beam - Charged
- Particle Beam - Neutral
- Plasma
- HPM:Area - Radar Tuned 'A' Band
- HPM:Area - Radar Tuned 'B' Band
- HPM:Area - Radar Tuned 'C' Band
- HPM:Area - Radar Tuned 'D' Band
- HPM:Area - Radar Tuned 'E' Band
- HPM:Area - Radar Tuned 'F' Band
- HPM:Area - Radar Tuned 'G' Band
- HPM:Area - Radar Tuned 'H' Band
- HPM:Area - Radar Tuned 'I' Band
- HPM:Area - Radar Tuned 'J' Band
- HPM:Area - Radar Tuned 'K' Band
- HPM:Area - Radar Tuned 'L' Band
- HPM:Area - Radar Tuned 'M' Band
- HPM:Area - Radar Directed 'A' Band
- HPM:Area - Radar Directed 'B' Band
- HPM:Area - Radar Directed 'C' Band
- HPM:Area - Radar Directed 'D' Band
- HPM:Area - Radar Directed 'E' Band
- HPM:Area - Radar Directed 'F' Band
- HPM:Area - Radar Directed 'G' Band
- HPM:Area - Radar Directed 'H' Band
- HPM:Area - Radar Directed 'I' Band
- HPM:Area - Radar Directed 'J' Band
- HPM:Area - Radar Directed 'K' Band
- HPM:Area - Radar Directed 'L' Band
- HPM:Area - Radar Directed 'M' Band
- HPM:Wide Band/EMP
- EMPC (Electro-Magnetic Pulse Cannon)
- HERF - VIS (Vehicle Immobilization System)